XII.—*Remarks on the Country between Wady Halfeh and Gebel Berkel, in Ethiopia, with Observations on the Level of the Nile.* By Sir G. Wilkinson, F.R.S., F.R.G.S.

[Read November 24, 1849.]

To the Secretary of the Royal Geographical Society.

Lucerne, June 28, 1849.

Sir,—In presenting to the Society the following remarks on the country between Wady Halfeh and Gebel Berkel, I must not omit mentioning my obligations to Cailliaud's Map, and that I have seldom found reason to differ much from that indefatigable traveller, either in his geography, or his general remarks respecting the country.

The rocks in the bed, and on both sides of the Nile from Wady Halfeh, or the second Cataract, as far as the Isle of Sai, are primitive, mostly granite and trap; the valleys are frequently wild and picturesque, amidst mountains not less than 800 or 1000 feet in height; and about latitude 21° appear some isolated mountains of sandstone, rising abruptly from the plain, and showing in a very interesting manner the junction of the primitive and secondary formations.

Similar isolated hills continue at intervals throughout the whole tract from that part to the province of Dongola, of no great elevation, seldom exceeding 400 feet; but so deceptive at a distance, that they appear at least three or four times that height. At Allandûli, on the desert opposite Sai, are numerous Egyptian pebbles, ranged upon the low graves of the Moslems, in humble imitation of the broad circles of black and white stones, on the tumuli of their pagan predecessors, which have been collected and brought to the spot for that purpose; and a little to the S. of this is a bed of fine grit, lying over sandstone, and full of pebbles, decomposed here and there, and showing how that stratum has once more been reduced to sand, and has left the hard pebbles alone on the surface of the rock immediately below it.

Soon after this the primitive schists, quartzose and trap rocks reappear, and continue (with some sandstone above them, about el Kedáyn) to the summit of the pass over the mountain plain that terminates the district of Dar Mahass. Here again, Gebel Arambéëh, and other isolated secondary hills, stand upon the granites; and these last, rising at length only a few feet above the surface of the plain, disappear just beyond the frontier of Dongola, and are not seen any more till the neighbourhood of Nooree, the whole of that part of Ethiopia being sandstone, on both sides the river, and Gebel Berkel itself being a coarse grit, very like that

of the "Red Mountain," near Cairo, which lies upon the limestone of the Mokuttum.*

It is to beds of grit, and recent sandstone, lying over the older sandstone in Ethiopia, that the Egyptian pebbles and petrified wood have once belonged, layers of which are found upon and under the alluvial soil at the side of the Nile, about Ordee, and other places in Dongola, having been brought down by the river from the upper country; and it is evident that they appertain to the same kind of formation, which once contained within it the petrified wood (of the so called "forest") now lying exposed above the limestone of the Mokuttum, as well as on the summit of the Libyan hills near the Natron Lakes.

The journey to Ordee, the present Turkish capital of Dongola, is generally made by the West bank, being much shorter than the Eastern road, owing to the many corners it cuts off; but it is far less interesting, being mostly a dreary waste of sand, intensely hot in summer, and equally cold in winter, when the N.W. wind sweeps the great expanse of the African desert. Narrow as is the strip of cultivable land on the east bank, that on the west is still smaller; and even the desert plants are wanting, which grow in the valley on the Arabian side; at least until you reach the dreary and monotonous plains of Dongola. The principal plants on the east bank (which are also among those that grow in the Maazy and Ababdeh deserts, east of the Nile) are the Senna; the Hargel (Cynanchum Argel), well known like the Senna for its medicinal properties, and remarkable for the fragrance of its white clustered flower; the Ösher (*Asclepias gigantea*); the Ghulga (*Periploca secamone*); some coarse grasses; a few Colocynths; the Merkh (*Cynanchum pyrotechnicum*); the Tónthob (*Sodada decidua*); the Tarfa and Athul (*Tamarix Gallica* and *T. Orientalis*); and numerous Sellem, Harráz, and other *Mimosas*, some of which are fine timber trees.

The few cultivated productions are cotton, indigo, dokhn or millet (*Phaseolus mungo*), some lupins and gilbán (*Lathyrus sativus*), very little barley, and Doora (*Sorghum vulgare*), and no wheat except in the Dar Shaykeeh. But palm-trees (*Nakhl—Phœnix dactylifera*), which are so valuable for their fruit and timber, are numerous; and the dates of Sukkôt are famed for their excellent flavour, superior even to the Ibreemee, or to those of Korayn. The *Dôm* or *Theban* palm-tree (*Hyphœne Thebaica*) is rare: indeed it grows more abundantly in Upper Egypt than in any other place, and it is one of the few instances in which a specific name has been properly taken from a particular district. The mimosas

* See more fully, on the geology of Egypt, Russegger's 'Reisen in Europa, Asien, und Afrika;' also Lieut. Newbold, F.R.S., 'On the Geology of Egypt,' etc., in the Journal of the Geological Society, vol. iv. 1848, p. 324.

and the *Ösher*, however, thrive in Dongola; and even the seemingly useless wood of the latter is turned to many purposes; but it possesses no beauty, and only seems to increase the dismal aspect of the desert plains or uncultivated lands of Dongola; after which the better cultivated and more productive fields of the Dar Shaykéëh are a relief. In two or three places I met with *Salvadora Persica*, and a variety of the Nebk (*Rhamnus Nabeca*), but that province is not remarkable for the number or variety of its botanical productions.* Yet the plains of Dongola, like many other portions of what is now the desert, were once highly productive, having been annually watered by the rising Nile; and many valleys and level spots, sometimes extending to a considerable distance from the river, were once within the reach of the inundation.

This change I suppose to have taken place between 3350 and 3550 years ago; when an earthquake, or the force of the water, having broken down the high barrier over which it till then had fallen at *Silsilis* (*Hadjar Selseleh*), in Upper Egypt, the level of the Nile was lowered between 30 and 40 feet throughout its whole course above that spot, and thenceforward ceased to inundate the very soil it had annually deposited in Ethiopia.

In that country it now falls short by about 28 feet of its former level, during the inundation; the inscriptions at *Samneh*, recording its annual height during the reigns of ancient Egyptian kings, who reigned from about 1700 to 1500 before our era, stand from 27 feet 8 inches to 28 feet above the highest Nile hitherto known, that of 1848; and extensive fields of old alluvial deposit, sometimes of many miles in length, and often from a quarter to 2 or 3 miles in breadth, with the additional evidence of water-worn rocks, are met with in numerous places above the second cataract.

In Nubia also, the same old alluvial deposit is traced far above the reach of the present inundations; and the same continues a little below Asouan, as far as the neighbourhood of Silsilis, from which I have been led to the conclusion that *at Silsilis*, and *not at Asouan* (as I first supposed), the bursting of the barrier took place, which had till then maintained it at its higher level.

Another effect of this sudden opening of a lower channel was to prevent the Nile from following the course it formerly held, down the valley lying to the east of the town of Asouan, and which, from the alluvial deposit I found in its bed, was evidently once the course of the river. A similar dry channel, 3 miles long, has been left at Egger, and another at Wady Absout, in the Dar Mahass; and the same evidences of the ancient level of the Nile may be traced throughout its course in Ethiopia.

* For these botanical productions see Sir J. G. Wilkinson's Second Series of 'The Manners and Customs of the Ancient Egyptians,' vol. i., chap. 11.—H. S.

I have already had an opportunity of treating this more fully in a communication lately sent by me to the Royal Society of Literature; and as I wish to leave room for some observations made in Egypt with the Aneroid barometer, I hope this will plead my excuse to the Society for noticing the subject so briefly on the present occasion.

Professor Chaix of Geneva has already submitted to the Society the result of his observations with the barometer in Egypt, and has given, among other valuable information, a calculation of the fall of the Nile from Philæ to the Mediterranean: it may therefore not be uninteresting to compare the following observations with those of the Professor, at the same time that they afford an opportunity of testing the value of that very convenient and sensitive instrument the *Aneroid* barometer.* They are made on going from Atfeh (at the junction of the Alexandrian Canal with the Nile) to Gebel Berkel, and on returning from the latter place to Alexandria, so that the gradual variation during the two seasons of the year may be ascertained and allowed for; but owing to the space they necessarily take up in a letter, I will refrain from adding my calculations on the fall of the Nile during its course, which are of less importance, as any one who feels sufficiently interested in the subject can supply this omission.†

SELECTION, by Mr. FRED. AYRTON, from Sir GARDNER WILKINSON'S Record of 552 Observations made by him with an ANEROID BAROMETER (of Messrs. Arnold and Dent) between Alexandria and Gebel Berkel; consisting of such of the Observations as were made under the most nearly corresponding Atmospheric Conditions of Wind, &c., and at the times most nearly corresponding to that of the Sun's passing the Meridian.

Date.	Hour.	Place.	Aneroid Barometer.*	Thermometer, Fahr.	Wind.	Distance by River.†	REMARKS.
1848.			Inches.	°		Miles, St.	
Oct. 24	2 p.m.	Atfeh	29·880	80	N.E.	. .	Light wind, clear.
	12 noon	Mehallet Ali . . .	29·865	82	N.W.	14	Very calm.
25	12	Aboo Nishábeh . .	·825	80	,,	67	Cloudy.
26	2¼ p.m.	Old Barrage of the Nile.	·785	81	N.	..	Very light wind, clear.
30	12 noon	Cairo	·750	75	W.	46	Clear, few clouds.
Nov. 1	1½ p.m.	Ditto	·825	74	N.W.	(Boulak)	Wind sometimes light, sometimes stronger, never violent; on land about 30 feet above the river.
4	1 ,,	Ditto	·800	74	,,	,,	Showery.

* The indications of the Aneroid Barometer are supposed to represent the atmospheric pressure in inches of mercury.

† The distances as far as Philæ have been measured off on the large French map; those between Philæ and Gebel Berkel from Cailliaud's 'Cours du Nil,' and are taken along the line of current of the river.

Selection, &c.—*continued.*

Date.	Hour.	Place.	Aneroid Barometer.	Thermometer, Fahr.	Wind.	Distance by River.	Remarks.
1848.			Inches.	°		Miles,St.	
Nov. 11	2¼ ,,	Kafr el Aiat	29·745	73	W.	34	Light wind, clear.
12	2 ,,	Between Beni Sooef and Isment.	·750	74½	N.W.	44	Ditto, ditto.
13	2 ,,	Gebel Sheikh Umbarak.	·740	73	,,	20	Ditto, ditto.
15	11¼ a.m.	Beni Hassan . . .	·770	71	,,	82	Ditto, ditto.
20	¾ p.m.	Osioot, by landing-place of El Hamra	·730	74	,,	80	Ditto, ditto.
22	12 noon	El Rahineh	·680	69	,,	28	Ditto, ditto.
24	10 to 2 p.m.	One m. N. of Girgeh	·710	70	,,	66	Very strong wind, clear.
25	½ p.m.	El Bekkhárres . .	·710	69	,,	24½	Calm, clear.
Dec. 3	2¼ ,,	Luxor	·660	79	,,	78	Ditto, cloudy.
5	¼ ,,	S. of Gebelayen . .	·550	74½	,,	24	Light wind and calm, cloudy.
,,	1 ,,	Metána	·545	76	,,	..	Strong wind, clear.
8	11¾ a.m.	To S. of El-Hegs* .	·525	65	,,	..	Rather windy, ditto.
11	1¼ p.m.	1 m. S. of Ombos*	·550	69	,,	86	Gusts, ditto.
12	11¾ a.m.	Asouan	·650	70	,,	25½	Light wind, ditto.
14	¾ p.m.	In cataracts	·555	67½	,,	3	Ditto, cloudy.
15	11 a.m.	Philæ	·610	69	,,	4	Ditto in gusts, ditto.
16	11 ,,	Tayfee †	·615	70	,,	..	Light wind, few clouds.
,,	1 p.m.	Kalábshee	·550	68	,,	34½	Ditto, ditto.
17	11¼ a.m.	Below Kostámne ‡ .	·590	68½	,,	19½	Ditto, clear.
18	1¾ p.m.	Bardee	·550	68	W.	32	Calm, few clouds.
19	6¼ ,,	Below Abd-el-Kereem.	·550	72	W.N.W.	..	Gusts, ditto.
20	2 ,,	2 m. N. of Amáda Temple.	·515	72	N.W.	..	Ditto, clear.
21	12 noon	Derr	·510	78	,,	37½	Calm, ditto; reflected heat, but in shade.
22	2½ p.m.	1 m. N. of Ibreem .	·430	76	,,	13¼	Ditto, ditto.
24	2¼ ,,	Gezeeret Farras . .	·435	67	,,	54½	Strong wind, ditto.
26	11¼ a.m.	Wady Halfeh § . .	·585	62	,,	21	Very strong wind, ditto; 15 feet above surface of river.
1849.							
Jan. 8	2 p.m.	Opposite Ordee . .	28·860	} 60 {	,,	} 257½	High wind.
11	1½ ,,	Ordee, on River . .	29·050		,,		
12	2¼ ,,	Goled	28·990	71	,,	50	Much wind.
15	11 a.m.	Meserkôt	29·030	69	,,	..	Strong wind; fog of sand.
,,	2¼ p.m.	Kooree	28·990	70½	,,	69	Strong wind.
16	1 ,,	El-Hegayr	29·035	64½	,,	20½	Ditto, cloudy.
17	11¾ a.m.	Between Koonroo and Gebel Berkel.	29·065	66	,,	..	Ditto, ditto.
,,	2 p.m.	Merrawee	29·070	67½	,,	19½	Ditto, ditto.
23	2 ,,	Gebel Berkel . . .	29·120	72	,,	6	Ditto, clear.

* At Silsilis, between El-Hegs and Ombos, the temperature was—

At sunrise, of the water of the Nile, Fah.	65°;	of the air,	in the shade,	62°		
10 a.m.	,,	,,	65	,,	,,	64
Noon	,,	,,	68	,,	,,	65
2½ p.m.	,,	,,	68	,,	,,	75
6 p.m.	,,	,,	67	,,	,,	66
8¾ p.m.	,,	,,	66	,,	,,	64

† At Tayfee—

11 a.m.	,,	,,	65	,,	,,	70

‡ At Maréëh—

7½ a.m.	,,	,,	64	,,	,,	59

At Kostámne—

Noon	,,	,,	65	,,	,,	68

1 mile N. of Dakkeh—

5 p.m.	,,	,,	65	,,	,,	71

At Korti—

10 a.m. to 2 p.m.		,,	64	,,	,,	65

§ At Wady Halfeh—

8 a.m.	,,	,,	59½	,,	,,	55

Selection, &c.—*continued.*

RETURNING FROM GEBEL BERKEL TOWARDS ALEXANDRIA.

Date.	Hour.	Place.	Aneroid Barometer.	Thermometer, Fahr.	Wind.	Distance by River.	REMARKS.
1849.			Inches.	°	Inches.	Miles,St.	
Jan. 25	1½ p.m.	Zoma	28·920	71	N.W.	..	Dead calm, clear, cold.
27	11½ a.m.	1½ mile above Old Dongola.	29·185	65	,,	93¾	Rather strong wind, clear.
28	½ p.m.	Khandek	·140	73	,,	32	Ditto, ditto.
29	2½ ,,	Ordee	·090	82½	,,	40	Calm, clear; the Nile had fallen at Ordee 1 ft. 8 in. since the 10th of January.
30	10½ a.m.	Ditto	·005	67	,,	..	Calm, clear.
Feb. 13	1½ p.m.	Ibreem	·485	64	,,	332	Light wind.
15	11½ a.m.	Dobát	·590	62½	,,	55¼	Strong wind.
16	1 p.m.	Maharraka	·485	61½	,,	9½	Lighter wind.
17	1½ ,,	Dandoor	·460	66	,,	28¾	Strong wind, but decreasing.
18	1 p.m.	Kalábshee	·540	65	,,	9½	Strong wind; very cloudy.
19	11½ a.m.	Philæ	·575	60	,,	23½	Wind rising.
23	1½ p.m.	5 miles N. of Silsilis	·460	66	,,	54	Strong wind.
24	1½ ,,	Edfoo	·570	72	,,	20	Violent wind.
Mar. 15	11½ a.m.	Thebes (Koorna) .	·475	64	,,	68½	Calm, cloudy; the river had fallen 8 or 10 feet.
24	2 p.m.	El Marágha	·580	72	,,	132	Light wind, clear.
25	1 ,,	Baroot (near Sitfeh)	·575	70½	,,	27	Ditto, ditto.
26	2 ,,	El Hassana (above El Howárka).	·615	81½	,,	44	Ditto, ditto.
28	11 a.m.	Beni Hassan (below Caves).	·685	77	,,	58	Ditto, ditto.
29	½ p.m.	Gisr el Agoos and Itsa.	·610	85½	N.	24	Calm.
31	11½ a.m.	El Haybeh	·600	66½	N.W.	..	Strong wind, clear.
Apr. 1	1 p.m.	1 mile above Beni Sooef.	·510	74	,,	76	Strong wind, cloudy.
3	2½ ,,	Toora	·585	77	,,	64	Light wind, cloudy.
6	2¾ ,,	N. end of Isle of Rhoda.	·700	71½	,,	7	Light wind, clear; River had fallen about 15 feet.
8	9½ a.m.	Ditto	·590	74	,,	. .	Strong wind, clear.
,,	3 p.m.	Ditto	·585	73	,,	. .	Ditto, ditto.
11	6 a.m.	Ditto	·685	67	W.	. .	Light wind, clear.
,,	7 p.m.	Ditto	·730	80	,,	. .	Ditto, ditto.
17	1 ,,	Atfeh	·720	79	N.E.	128	Ditto, ditto.
20	12 noon	Alexandria	·755	79	,,	48	Ditto, ditto.

NOTE.—These observations are not sufficiently conformable in the elements they offer for the calculation of the differences in altitude of the several places at which they were made, to admit of a trustworthy or useful result, in that respect, being deduced from them: but it has been thought desirable to insert them as an appendix to Sir Gardner Wilkinson's paper, with the view of furnishing a specimen of the employment of the Aneroid barometer in the investigations appertaining, to physical geography; and in the hope that incitement may be thereby afforded to gentlemen with adequate leisure and opportunity to prosecute the subject to a conclusion which will enable this very convenient and portable instrument to be used by the geographer with success for determining differences of level—at least such differences as are not great, as in the present instance.

For making observations from which useful results can be calculated, whether with the Mercurial or Aneroid barometer, it cannot be too strongly borne in mind by travellers that they should, as much as possible, make them under the same conditions of wind and of local atmospheric currents, and, as nearly as they can, to the time of the sun's passing the meridian at the place of observation. See on this subject the admirable Memoirs by Ramond, collected into 1 vol. 4to., Paris, 1811, entitled 'Mémoires sur la Formule Barométrique de la Mécanique Céleste, et les Dispositions de l'Atmosphère, &c.'

Note by Mr. F. Ayrton on Professor Paul Chaix' calculation of the volume of water flowing through the channel of the Nile at the season of its flood. See 19th vol. of the 'Journal of the Royal Geographical Society,' page 149.

Professor Chaix states, on the authority of Lenant Bey, that, in the dry season, the breadth of the Rosetta or western branch of the Nile, measured at a short distance below the point of divergence of its waters through the Delta, is 435·57 mètres with a mean depth of 2·66 mètres, and a mean velocity of 0·795 mètres in a second, which gives a volume of 921·1 cubic mètres per second; and that the corresponding quantities for the Damietta or eastern branch of the river are 253·55 mètres, 4·96 mètres, and ·814 mètres, giving a volume of 821·82 cubic mètres per second. The sum of these two volumes is therefore 1742·92, which we may call 1743 cubic mètres. Professor Chaix then continues, but without citing the elements of his calculation, 'The body of water flowing during the greatest floods would be 5536·086 cubic mètres a second through the Rosetta branch, and 2629·979 cubic mètres through the Damietta branch.' He then assumes the sum of the two last mentioned numbers to be 8,166,065, and is thence necessarily led to the conclusion that the discharge of the Nile during the flood is in the ratio of 8,166,065 to 1742 (for 1743 as shown above), that is, 4600 times greater than in the dry season, and that it would so require less than 14 hours to fill up the basin of the Lake of Geneva with a superficies of 545 millions of square mètres and a mean depth of 80 mètres; and he adds that 'he cannot help doubting the accuracy of the measures which lead to such prodigious results.'

The inaccuracy results from an oversight in having omitted to insert the decimal point in the notation of the figures 8,166,065, expressing the total volume discharged by the two branches during the flood. The calculation should have been as follows:—

	Cubic mètres.
Volume of water flowing through the Rosetta branch during the flood	5536·086
Through the Damietta branch	2629·979
Total volume per second	8166·065

Which quantity, divided by 1743 (the number of cubic mètres constituting the volume of water during the dry season), will give 46 85, which is the number of times that the volume during the flood is larger than that during the dry season.

The cubic contents of the Lake of Geneva will be 545,000,000 of cubic mètres, multiplied by 80, equal to 43,600,000,000 cubic metres, which, divided by 8166·065, will give 5,339,169 seconds, equivalent to 61 days 23 hours, and which is the time that would be required for filling up the Lake of Geneva if the stream of the Nile at its flood were pouring into the lake.

From the correction now made, it will be seen, on referring to p. 150 of Professor Chaix' paper, that the volume of the Nile during its flood should have been stated to be not more than twice that of the Neva, instead of 2000 times.

ERRATUM.

In Miss Colthurst's table, part 2 of vol. 19, page 192, substitute at the bottom 6086·43 feet for 6075·78.